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Capture and Storage Projects at IVC-SEP

Faramarzi, Leila; Darde, Victor Camille Alfred; Niu, Ben; Lerche, Benedicte Mai; Sadegh, Negar; Waseem Arshad, Muhammad; Fosbøl, Philip Loldrup; Breil, Martin Peter; Yan, Wei; Stenby, Erling Halfdan

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CO_2 capture and storage projects at IVC-SEP

DTU Chemical Engineering

PhD. and master students: Leila Faramarzi, Victor Darde, Ben Niu, Benedicte Mai Lerche, Negar Sadegh, Muhammad W. Arshad(Master stud.)
Research staff: Philip L. Fosbøl, Martin P. Breil, Wei Yan
Faculty: Erling H. Stenby, Kaj Thomsen, Georgios Kontogeorgis, Michael L. Michelsen, Nicolas von Solms

Why CO_2 Capture and Storage (CCS)?

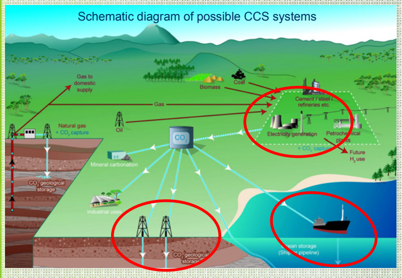


Figure 1: Sketch of CO_2 flow in electricity production

CO_2 is a greenhouse gas and during 2007 the Intergovernmental Panel on Climate Change (IPCC) concluded that the major contribution to the global warming is CO_2. Electricity produced solely by renewable energy-sources like wind, solar, or wave power is not possible yet, since the full scale infrastructure and knowledge is not available. In the meantime while these expertises are being developed the existing proven state-of-the-art know-how must be taken into use in order to lower the emission of CO_2. Figure 1 shows a principle sketch of the CO_2 flow in electricity production. The capture of CO_2 is performed at the plant and storage of CO_2 in nearby underground aquifers or in oil reservoirs, which as a side effect may enhance oil production. Figure 2 shows the known solvent-based CO_2 capture process studied at IVC-SEP.

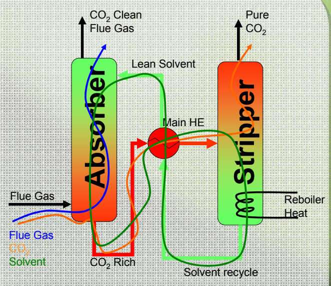


Figure 2: Solvent based CO_2 capture Facility. Solvent is recycled and pure CO_2 is produced

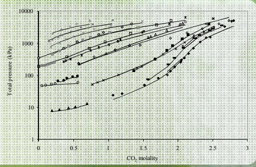
Capture

Process Optimization & Development

The solvent used in the equipment of figure 2 consists typically of an amine component. It binds and removes the CO_2 from the flue gas in the absorber. The CO_2 rich solvent is heated in the stripper and pure CO_2 is released which is transported for on or off-shore storage. In IVC-SEP the phase equilibria are studied in order to improve current technology. The technology is extended for simultaneous capture of CO_2 and H_2S in order to lower the cost.

Improved Design of CO_2 Capture

A model of the thermodynamic properties of amines is being created by Leila Faramarzi in order to improve column calculations.



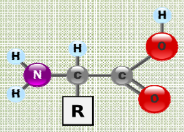
Combined CO_2 and H_2S capture

The aim of the PhD study by Negar Sadegh is to develop a thermodynamic model which can describe acid gas-alkanolamine mixtures over extensive pressure and temperature ranges.

Solvent Design & Selection

The amine solvent may not be the most optimal solvent for CO_2 capture. Several interesting alternative solvents are being studied in IVC-SEP.

Amino Acids



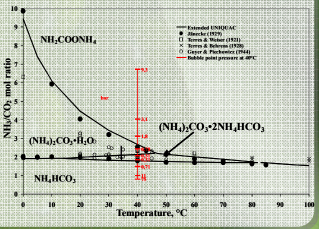
Recently the PhD project by Benedicte M. Lerche was initialised in order to study the process improvements of using amino acid solvents. The benefit of these solvents are low toxicity, low volatility, high stability to oxidative degradation, leading to low solvent loss.

Ionic Liquids

Ionic liquids (IL) are liquid salts. They have similar benefits to amino acids and may be used for combined capture of CO_2 and SO_2. IVC-SEP just received a large grant in collaboration with DTU Chemistry for developing new IL solvents. Muhammad W Arshad is finishing his master on this topic.

Aqueous and Chilled Ammonia

Victor Darde is involved in the thermodynamic model development of the electrolytic CO_2-NH_3-H_2O system.



Technology Evaluation & Experimental Work

Mathematical Column Models

Philip L. Fosbøl, Martin P. Breil and Leila Faramarzi are involved in the creation of software packages (CAPE-OPEN) for the calculation of heat and energy balances for the figure 2 columns as sketched in figure 3.

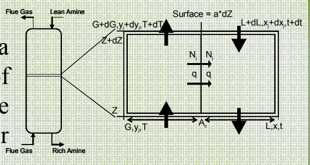


Figure 3: Column balances

Experimental absorber pilot

Several master students have been, and are, involved in building an absorption column as shown in figure 4. This is done in order to test packings and solvents. Lars Kiørboe and Nicolas von Solms are supervising these projects.

Figure 4: Absorber pilot

Storage

Experimental equilibrium and injection tests

Two types of storage experiments are performed in IVC-SEP. CO_2-Chalk interaction test as shown in figure 5 by Ben Niu and CO_2 solubility in brine as shown by figure 6 performed by Wei Yan and students.

Figure 5: CT-scanner injection tests

Figure 6: HP brine tests

Model of CO_2 Injection

The aim of the studies by Ben Niu is to build a CO_2 reservoir injection model in order to predict the experimental findings from the CT-scanner. Figure 7 shows the planned modelling methodology.

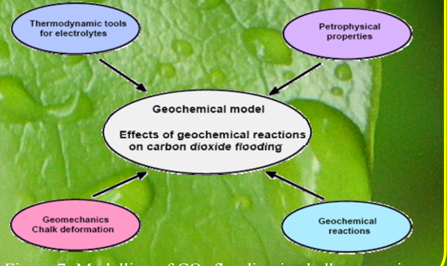


Figure 7: Modelling of CO_2 flooding in chalk reservoirs